# *ANTHROPOLOGICAL QUARTERLY*

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## CONTENTS

## ANNOUNCEMENT OF CHANGE OF TITLE

Starting with Volume 26, No. 1, January, 1953, the title of PRIMITIVE MAN, the quarterly periodical of the Catholic Anthropological Conference, is being changed to ANTHRO-POLOGICAL QUARTERLY.

During the last few years there have been a number of indications that the original title is no longer altogether a satisfactory one. It is felt that the new name ANTHRO-POLOGICAL QUARTERLY indicates more accurately the scope of the journal and that the change is best made upon the completion of twenty-five volumes under the former title.

THE EDITORS

# BRAIN MORPHOLOGY AND TAXONOMY

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It is remarkable how small a role the morphology of the brain plays at present in the interpretation of relationships of the various groups of primates. One would naturally expect that an organ such as the brain, which gives motor impulses out to, and receives impulses directly or indirectly from all parts of the body, and therefore registers its manifold activities, would reflect in its structure the status of the total organism, and hence be of value in taxonomy. The motor and manipulative behavior of the primate organism is dependent upon the cortex of the cerebral hemispheres and this dependence upon the cortex must be reflected in its development and differentiation. One must presume that the cellular structure of the brain differs in groups with different levels of organization, however difficult this would be to determine as there is probably much individual variation.

About a hundred years ago, Gratiolet (1854) gave an account accompanied by illustrations of the brain of various genera of infra-human primates and observed advanced characters in the Colobinae (Semnopithecinae) over lower primates. Kohlbrugge ('03) rejected the idea that the fissuration of the brain was characteristic for genera below Hylobates and Semnopithecus. Not a single sulcus or the form of a sulcus was characteristic of a particular genus according to that author. This would be the conclusion from a study of many genera if no account were taken of the developmental stage of the animal, whether young or adult.

In an early paper the present writer ('36) pointed out that there is a considerable difference in the fissuration of young and adult specimens. The brain is a dynamic organ undergoing changes during its development even though all the primary sulci are present in the early stages. If adult brains of genera higher in the zoological scale be compared with adult brains of lower

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genera, a greater degree of differentiation of the cortex by sulci will be noted in the former. Of course it is generally recognized that there is a more complex fissuration in higher primates and man than in lower primates, but the question is to what extent the brain of more nearly allied genera or groups of subfamily rank can be distinguished from one another by the fissuration or other morphological features of the brain. Here it may be noted that even with exactly the same sulci in two genera, the form of the sulcus in one genus may be significant in that it reveals underlying growth antagonisms or it indicates by its position an increase in development of the underlying cortical areas.

This morphological feature has been largely overlooked in the past. It is probably an example of what Ariëns Kappers had in mind when he drew attention to the fact that the study of the surface morphology of the brain has not kept pace with the increasing number of researches on its microscopic anatomy. "This is the more to be deplored," he continues, "since the added knowledge of the finer anatomy of the cortex warrants the hope that the significance of the surface relations may gradually become clearer and their importance more thoroughly recognized" (1936a, II, p. 1517).

These surface relations are indicated by the pattern of the sulci and as the sulci are in close association with the cortical areas, either forming approximate limiting borders or axial furrows within the areas, much can be learned from their presence and the modifications which they undergo in the ascent from lower to higher forms. In this ascent there is, by and large, an increasing differentiation of the cortex, so that an increasing number of gyral entities appear which are demarcated by the sulci and fissures.

This paper deals with the Order Primates to which man morphologically also belongs. The brain specimens referred to are mostly from the Collection of the U.S. National Museum.

Of any knowledge of the brain of fossil primates including man, we are of course restricted to casts taken from the inside of the skull. These endocranial casts show depressions on their surface which indicate the location of the sulci and fissures of the corresponding brain. Other markings on the surface may

erroneously be interpreted as representing fissures. This has led many authors to the conclusion that nothing can be learned of the fissuration of the brain from endocranial casts of groups long extinct. But it is certainly true in some cases that much can be learned and the matter is of such importance that we should endeavor to glean all that the endocranial casts reveal with a high degree of probability if not certainty.

Before discussing the brain morphology of living groups of primates, a few general observations may be made. In some genera of small animals, the outer surface of the cerebral hemispheres is quite smooth, so that little concerning fissuration can be said, except a reference to the fundamental primate sulci on the medial surface. Again external brain morphology alone cannot determine whether the genus under consideration should be classified under a particular infraorder, superfamily etc., or under some other of the higher categories. Other anatomical structures must be taken into consideration of which the taxonomists take note. And among taxonomists of the primates there is a considerable difference of opinion concerning the position of certain genera in the scheme of classification. As Simpson ('45) observes regarding the primate order "there is perhaps less agreement as to its classification than for most other orders."

But external brain morphology, as we shall see, can throw some light on the closer or more distant relationship of some genera, and in some cases suggest the more probable position of a genus in the scheme of classification, where taxonomists may differ.

### ORDER: PRIMATES

#### SUBORDER: PROSIMII

The brain of the Aye-Aye (Daubentonia or Cheiromys) appears to be the most primitive of all primates from the point of view of its fissuration and the largely uncovered cerebellum. These features recall the conditions in the non-primate brain especially as seen in the carnivora. Elliot Smith ('02) regarded the brain as exhibiting regressive changes.

The primitive condition of the surface morphology of the Aye-

Aye is evident from the presence of a suprasylvian arc surrounding the shallow depression called the pseudosylvian. This condition is well illustrated in the brain of a carnivora (Fig. 1, A). Here the arcuate gyri 1, 2 and 3 are on the surface. In primates generally, gyrus 1 and the anterior arm of gyrus 2 are operculated and form an early stage of the insula. The suprasylvian sulcus (ss) and the pseudosylvian (ps) become superficially united in the primates. The suprasylvian sulcus constitutes the main furrow of the Sylvian fissure. (Fig. 1, B, S). The posterior section or postsylvian (sp) of the suprasylvian arc becomes separated as the parallel sulcus or superior temporal (ts) and the posterior arm of the second arcuate gyrus (2′) remains on the surface.

In some respects, however, the brain of the Aye-Aye shows primate characters such as the relatively large hemispheres and the calcarine complex on the medial surface which is similar to that in lemurs. Daubentonia has been given a subordinal rank by some authors. Simpson ('45) places it in the infraorder Lemuriformes.

Representatves of the Prosimians in the Collection of the U.S. National Museum, are several species of the genus Lemur, Nycticebus or Slow Loris and Tarsius, the Spectral Tarsier. In the lemur brain a central sulcus may occur, though frequently it appears in separate sections. The cerebral hemispheres leave uncovered a considerable part of the cerebellum but some advances over the Aye-Aye are seen in the sulcal pattern. The suprasylvian sulcus becomes confluent with the pseudosylvian to form the Sylvian fissure and as in all primates except the Aye-Aye, the postsylvian is separated as the parallel sulcus. The intraparietal (ip) or lateral sulcus of non-primates, is a simple arc and posterior to it a transverse sulcus, or postlateral may be present.

Nycticebus shows some advance over the lemur brain in that the cerebellum is largely covered by the cerebral hemispheres. The intraparietal sulcus is united with the Sylvian fissure to form a continuous furrow. The brain of Nycticebus is quite distinct from that of the lemur and both are more primitive in their fissuration than the platyrrhines or New World monkeys. Brain morphology of the prosimians in so far as it shows little cortical
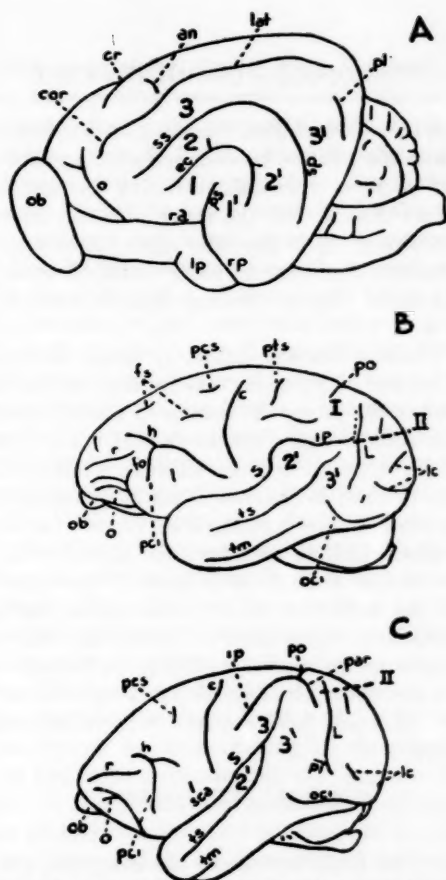
Figure 1, A. Brain of a carnivora, Cerdocyon thous (Vulpes). Adult o.
Ob., olfactory bulb; lp., piriform lobe; o., orbital sulcus; ra., rhinal anterior; rp., rhinal posterior; ps., pseudosylvian; ec., ectosylvian; ss., suprasylvian; sp., postsylvian; cor., coronal; lat., lateral; pl., postlateral; cr., cruciate; an., ansate; 1, 2 and 3, arcuate gyri.

B. Brain of Ateles. S., Sylvian fissure; ip., intraparietal sulcus; L., lunate; c., central; r., rectus; fo., fronto-orbital; pci., precentral inferior (arcuate); h., its horizontal branch; fs., frontal superior; pcs., precentral superior; pts., postcentral superior; po., parieto-occipital; lc., lateral calcarine; oci., inferior occipital; ts., temporal superior (parallel); tm., mid-temporal. I and II, first and second parieto-occipital transition gyri.

C. Brain of Cebus. par., paroccipital; pl., prelunate.

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differentiation by sulci and little reduction of the olfactory bulbs, harmonizes with the position these animals occupy in the taxonomic scale. It would be more difficult to link the prosimians with the platyrrhines than to link the latter with the catarrhines or Old World monkeys. It is generally agreed among taxonomists that the prosimians represent an early divergent branch from a basic primate stock. The morphology of the brain is in harmony with this view.

Tarsius. There is but one species of living tarsiers, namely the spectral tarsier. This genus was formerly given subordinal rank. Simpson ('45) places the tarsiers in the infraorder Tarsiiformes which includes many extinct species. The brain differs strikingly in its appearance from all other brains. The outer surface of the cerebral hemisphere is smooth, with only a slight depression to represent the pseudosylvian furrow. A short sulcus in this depression probably represents the suprasylvian sulcus, a constituent of the lemurine Sylvian fissure. The cerebral hemispheres cover the cerebellum to a greater extent than in lemurs but not to a greater degree than in Nyticebus. The triradiate calcarine complex on the medial surface of the brain is similar to that in lemurs and other primates. So far as external morphology indicates, Tarsius would hardly occupy a more advanced status than the lemurs.

### SUBORDER: ANTHROPOIDEA

*Platyrrhines*

Hapalidae. The brain surface of the marmoset (Hapale) is quite smooth having on the lateral surface only the Sylvian fissure and the parallel sulcus, though the brain is about the same size as the well fissurated brain of Nycticebus. Advanced features over the lemur brain are the reduction of the olfactory bulbs and the extent that the cerebral hemispheres overlap the cerebellum. Little can be inferred from the external morphology of its brain as to the relationship of Hapale to other primates on account of the paucity of fissures.

Cebidae. In this family of plathyrrhines, there is considerable variation in the sulcal pattern. The arcuate sulcus, typical of all groups of the suborder Anthropoidea, appears for the first time.

It is the homologue of the precentral inferior sulcus of higher primates (Fig. 1 pci, B & C). Some members of the family Cebidae show a simple and poorly fissurated cortex with rudimentary sulci. This is true of Alouatta where the arcuate sulcus is poorly developed and indeed may be considered a dubious furrow. The intraparietal sulcus (ip) is confluent with the Sylvian fissure as in Ateles. The brain of Ateles (Fig. 1, B) is the most specialized of the platyrrine brains in our series. In conformity with its size, it is well fissurated but does not exhibit cortical differentiation as brains of the same size in higher genera. The brain of the genus Cebus (Fig. 1, C) shows a fissural pattern that is basically similar to, though less developed than that of some of the simpler fissurated catarrhines such as the macaque. The precentral inferior sulcus (pci) is closer to the central sulcus (c) than in Ateles—a progressive feature. Another advanced feature in the Cebus brain compared with that of Ateles is the emergence of a gyrus separating the intraparietal (ip) from the Sylvian fissure (S). This condition persists in all catarrhines and the intraparietal sulcus undergoes many changes in form in the ascending scale of genera.

Anthony ('48) made a detailed study of the convolutions of 85 brains of platyrrhines in the Collection in the National Museum of Natural History in Paris. Basing his classification upon the manner of the opercularization of the insula and the growth antagonism of the fronto-parietal-occipital regions, the author groups the platyrrhines into two families. In the first group the first arcuate gyrus and the anterior arms of the second and third gyri (Fig. 1, A, 1, 2, 3) are operculated so that the intraparietal (ip-lateral of the carnivora brain) and the Sylvian are confluent, forming one continuous furrow, the intraparietal-sylvian complex (Fig. 1, B). The posterior arms of the gyri, 2′ and 3′ remain on the surface. This group, the family Atelidae includes the genera Aotus, Alouatta, Saimiri, Lagothrix, Eriodes (Brachyteles) and Ateles. In the second group this union of the intraparietal sulcus and the Sylvian does not occur and the third arcuate gyrus is on the surface (Fig. 1, C). This group, the family Cebidae includes the genera Callithrix (Callicebus), Pithecia, Brachyurus (Cacajao) and Cebus.

Systematists would probably not agree with Anthony in giving the rank of family to these groups which are usually included in several subfamilies of the family Cebidae. But here it is a question of the relationship of the genera as indicated by brain morphology.

Anthony assigns importance to the opercularization of the anterior arm of the third arcuate gyrus which is correlated with the expansion of the frontal lobe. He notes, however, that in one hemisphere of Lagothrix the union of the intraparietal and Sylvian fissures, indicative of opercularization, did not occur. Elliot Smith ('02, pp. 404 and 406) observed that in three hemispheres of Lagothrix, the union of these two fissures also did not occur. A submerged gyrus is always present between the two fissures in our specimens of Ateles.

It will be noted that Anthony places Saimiri in the family Atelidae and Callicebus in the Cebidae on the basis of brain morphology. Schultz and Straus ('45) and also Simpson ('45) place Saimiri in the subfamily Cebinae and Callicebus with Aotus in the subfamily Aotinae. Since an interruption of the intraparietal-sylvian complex occurs in some specimens of the first group, their continuity would seem to be too tenuous a basis to have weight in classification. Nevertheless Anthony seems justified in making this grouping by reason of the general features of the parietal and occipital lobes, and he receives support from several early taxonomists who placed Saimiri near Aotus rather than with Cebus. Of interest, too, is the fact that according to the data given by Schultz ('41) the curve of the relative cranial capacity of Saimiri is very low in the scale of primates and lies between Alouatta and Aotus, all three being inferior to Cebus.

A second basis for Anthony's grouping of the platyrrhines, and correlated with the opercularization of the insula, is the antagonism of the fronto-parietal-occipital regions. The growth direction of the frontal and parietal lobes is posteriorly; the occipital lobe also tends, according to Anthony, to grow posteriorly but is prevented by the cerebellum. It therefore must grow anteriorly.

This viewpoint might lead the reader to suppose that in each individual brain, the occipital lobe would actually meet such a

resistance, which is hardly the case; for if not impeded by other factors, the occipital lobe would not find much of an obstacle in the cerebellum, as illustrated by its great extension posteriorly in the brain of Saimiri. The limited intracranial space would appear to be a more effective obstacle. But we must infer that the form of each, brain and cranium, is established by correlated hereditary factors and that the growth factors of each become integrated.

The parieto-occipital fissure (po), formed as a result of this growth antagonism, gradually deepens, cutting into the dorsal surface for varying distances, according to the type. Surrounding its lateral end is the arcus parieto-occipitalis or first *pli de passage externe* of Gratiolet (Fig. 1, B, I). The second *pli de passage externe* or parieto-occipital transition gyrus lies between the branched ending of the intraparietal sulcus (transverse occipital) and the lunate sulcus (Fig. 1, C, II). In C, gyrus I is rudimentary and embedded in the parieto-occipital fossa, or it may be absent. In B of figure 1, gyrus II is operculated by the lip of the lunate (L).

The progressive stages are traced by the author in the Cebidae to a complete opercularization in some specimens. In the Atelidae conditions are quite different. The first transition gyrus greatly increases in size and the lunate is pushed backward, and a *reduced* operculum results.

The lunate sulcus (L), in addition to the parieto-occipital fissure, is regarded as primarily compensatory to the fronto-parietal-occipital growth antagonism. It performs this function, but it may appear where there is no growth antagonism. In the folding of the cortex, the location of the sulci is not a haphazard one due to superficial mechanical causes, but is influenced by the presence of distinct cytoarchitectural areas to which they form approximate boundaries or within which they form axial furrows to accommodate the increased growth of cortical areas. Thus the lunate sulcus is produced at the anterior boundary of the striate area and it forms in cases where there is no parieto-occipital antagonism. This is true for example of the adult lemur brain or of the fetal stages of types where the lunate in the adult stage becomes a deep fossa due here to growth antagonism.

The degree of opercularization of the parieto-occipital gyri varies with the age of the organism and there is also individual variation in the adult stage. It may be useful to recall here the conditions in various genera of primates to illustrate what may be regarded as primitive stages and what progressive in the phylogenetic sense. The occipital operculum is hardly represented in some of the playrrhines, where only a non-opecular lunate sulcus is present (e.g. Alouatta). In Cebus, especially Cebus apella, the opercularization may be complete so that the lunate becomes confluent with the paroccipital (par) or transverse occipital of figure 1 C.

In the Cercopithecidae the occipital operculum reaches its maximum development, as in the macaque. In the fetal brain of the macaque, the operculum is not yet developed and the transition gyri are exposed, a less progressive stage than in the adult. In the langurs the operculum begins to recede, due to the increased development of the parietal lobe. This is a more progressive stage than the complete opercularization seen in the adult macaque. A further reduction of the operculum occurs in the gibbon and the great apes, and the operculum finally disappears in most human brains. The fronto-parietal-occipital antagonism is not constant in the three brain lobes in all groups of primates. Rather an increased development of the occipital takes place in some groups, and of the parietal or frontal in others.

The fact that in our large specimens of Ateles the lunate is located anteriorly and operculates the second transition gyrus, is evidence that the occipital operculum is of the incomplete rather than the reduced type. If it represented the reduced type, then the occipital lobe in several of the human brain specimens in our series is more primitive than that of some specimens of Ateles. For in these human brains the occipital operculum is more highly developed. Both vertical and lateral types of opercula are there represented. Landau ('23) referred to the Ateles occipital operculum as "incomplete," which seems to be a more appropriate term than "reduced."

Of importance in this matter is the internal organization of the occipital lobe. Solnitsky and Harmon ('46) have concluded from

their detailed study that the structural organization of the striate area in platyrrhines is inferior to that of the catarrhines. In the descending series of organization from Homo to Cebus, they place Ateles next to Macaca and above Cebus.

As to the status of the Ateles brain as a whole compared with the Cercopithecidae, the final answer must be found in the cyto-architectural differentiation of the entire cortex. The present writer believes, however, that to the extent that the sulci are present, they reflect this differentiation in great measure. From the fact that the higher primates show clearly a relation of the sulcal pattern to the cortical areas and that in these the gyral entities are developed, it seems reasonable to rank the brain in the order that the gyri tend to be demarcated. On this basis, the brain of Ateles, considered the most highly specialized of the platyrrhines, is less evolved than the Cercopithecidae.

The association of the genera in the two series of related types of platyrrhines as given by Anthony appears justified. But as already noted, giving each group the status of a Family, would not be in agreement with the views of modern taxonomists. Lagothrix, Eriodes (Brachyteles) and Ateles are usually grouped in the subfamily Atelinae while Alouatta forms a separate sub-family; also Aotus and Callithrix (Callicebus) are grouped in the subfamily Aotinae.

According to our limited platyrrhine material, the brains of the genera representing the three subfamilies Alouattinae, Cebinae and Atelinae are quite distinct and harmonize with the classifica-tion. It is from such harmony in the case of well established categories, that some assurance is given that, where disagreement exists among taxonomists as to the proper rank of a particular genus, brain morphology may contribute to a solution.

*Catarrhines*

Cercopithecidae. In the two subfamilies of the Cercopi-thecidae, namely the Cercopithecinae and the Colobinae, the representative genera of each subfamily show a characteristic brain morphology. Within the Cercopithecinae the sulcal pat-tern in the different genera is very similar. Papio and Man-drillus resemble one another closely in cortical pattern and it is

of interest to note that Schultz and Straus ('45) regard these two as a single genus. The brain of these two animals can easily be distinguished from that of Macaca. It would be difficult, however, to distinguish Thercopithecus, Cynopithecus, Cercocebus and Cercopithecus from one another and from Macaca by the sulcal pattern, though the last named genus lacks a well defined lateral calcarine sulcus. Of the above genera, Cynopithecus is considered a subspecies of Macaca by some authorities. In an adult specimen of Cercocebus, the intraparietal sulcus approaches the more advanced form seen in Papio, where an inverted V-shaped pattern of the combined intraparietal and lunate sulci seen in Macaca is modified.

This modification of the intraparietal sulcus present in Papio and Mandrillus is significant and serves as an example of a change of form of a sulcus that indicates an underlying cortical development, as mentioned at the beginning of this paper. Instead of forming an inverted V-shaped pattern with the lunate and the apex near the dorsal border of the hemisphere as in the macaque, the intraparietal sulcus shifts laterally and assumes a more horizontal direction, joining the the lunate at almost a right angle. This means that the superior parietal lobule is being further developed. In some specimens this lobule is marked off from the superior postcentral gyrus by a superior postcentral joining the intraparietal. This change of the intraparietal sulcus to a more horizontal direction is complete in the gibbon where a superior parietal lobule is demarcated from the inferior lobule by this sulcus.

The Colobinae, though having small and poorly fissurated frontal lobes, show advances over the Cercopithecinae in some morphological features such as the partial emergence of the first parieto-occipital transition gyrus. The two genera of this subfamily, Nasalis and Presbytis (Semnopithecus) can be distinguished from one another, the former having a wavy and more laterally placed intraparietal, which is provided with a long acuminate process. In all cases, however, adult specimens of the different groups should be compared, as young specimens may not show these differences. The shape of the brain may be an additional feature distinguishing the brains of different genera.

*Pongidae*

Hylobatinae. There is a considerable advance in cortical differentiation as expressed by the sulcal pattern in this subfamily. Though the brain of the gibbon is small it exhibits some advanced morphological features that harmonize with the taxonomic position assigned to this genus. The most obvious change is in the parietal lobe where the intraparietal sulcus becomes horizontal, indicating a further development of the superior parietal lobule. The emergence of the first parieto-occipital transition gyrus pushes back the dorsal part of the lunate. Especially noteworthy in most specimens, is the clear demarcation for the first time in the ascending series, of a postcentral gyrus which even appears in the fetal brain. The anterior ventral part of the intraparietal sulcus now becomes the inferior postcentral sulcus, a destiny foreshadowed in some of the Cercopithecidae.

The cortical differentiation by which gyral entities become demarcated, such as we recognize in higher primates and especially in the human brain, is an index of the approximate taxonomic position of the genus. Without going into details here, this cortical differentiation is at once apparent. No more striking illustration of the influence of mere size of brain on fissuration on the one hand, and on the other the cortical differentiation reflecting the taxonomic position of the organism, could be cited than a comparison of the Ateles and gibbon brains. The range in size of brain is approximately the same in both genera, yet the cortical differentiation in Ateles is much less. And both reflect their position in the zoological scale.

Ponginae. The brains of the three great apes, orang-utan, chimpanzee and gorilla can be distinguished from one another, at least in the adult stage. This conforms to the generic distinction of these animals. The brains differ both in form and in the fissural pattern. In cortical differentiation as well as in size they differ greatly from the Cercopithecidae by the addition of new sulci, change in position of phylogenetically early appearing sulci and the splitting off from them of parts which take on an independence with the expanding cortex, the whole process being built upon a basic primate pattern.

If in the opinion of taxonomists the genera of the Cercopithe-cidae are well established categories while the brains of some of these genera, as we have seen, show little if any external dif-ferences, it would seem that the brains of the great apes indicate that we have here true genera. Mayr ('50) suggests that on the basis of the degree of differences used in recognizing valid genera in non-primates, the chimpanzee and the gorilla should form one genus. Using the same standard, the author would probably not recognize as true genera some of the groups of Cercopithecidae referred to in previous pages. If so, brain morphology of these groups would be in accordance with this view. But the brain morphology of the chimpanzee and the gorilla indicate that we have here distinct genera.

One of the important developmental features in the brain of the great apes is the appearance for the first time of an inferior frontal sulcus. Usually the horizontal branch of the arcuate in apes was interpreted as homologous with the inferior frontal sul-cus of the human brain, though some early investigators rightly regarded this horizontal branch and the sulcus rectus as elements of the middle frontal sulcus. Ariëns Kappers as late as 1936 re-garded the homologue of the human inferior frontal sulcus in apes as uncertain. Ample proof that the inferior frontal sulcus is a new sulcus appearing for the first time in each of the great apes, but not in all specimens, was given in the writer's recent publication.

The variability in the sulcal pattern, especially where the sulci become numerous as in the great apes and man is indeed great, but more striking than variability is the constancy of all the principal sulci throughout the primate series, so that one must conclude that a basic primate pattern and also that a character-istic sulcal pattern in the various taxonomic groups is genetically determined. This pattern is superficially modified in a small way by the intervention of purely mechanical causes such as the emergence of the parieto-occipital transition gyri causing the appearance of a well-developed lateral calcarine where otherwise a mere trace of the sulcus is present. Tertiary sulci are in-constant and represent individual variations.

The axial furrows serve the purpose of accommodating a large

area of cortex within a limited surface space. The lateral calcarine and the lunate serve as examples of an axial and a limiting sulcus respectively, in the same region. It is known that the lunate sulcus does not limit the striate area very precisely in all primate brains. And this holds good for the human brain when a lunate is present but it is nevertheless an approximate boundary of that area.

Ngowyang ('37) gives many illustrations showing the extent of the striate area and its relations to the lunate in primate brains. There is here considerable variability in the extent of the striate area, but it is remarkable how close a relation exists between the lunate and the striate area especially in the macaque, and chimpanzee. In the gibbon and orang-utan, the area is tongue-shaped and recedes from the lunate dorso-medially. Laterally the striate area is close to the lunate but ventrally and medially, the area separates from the sulcus. The recession of the dorso-medial part of the striate area is shown in Ngowyang's figures of the gibbon (Fig. 9), of the orang-utan (Figs. 11 to 14) and of the chimpanzee (Fig. 15). He does not mention a short sulcus which borders the actual position of the striate area approximately in some cases and very precisely in others. This sulcus, the present writer ('50) called the postlunate and it is illustrated in Fig. 62 of the orang-utan in that publication.

The addition of a new sulcus to limit more precisely a shifting cytoarchitectural area recalls a similar process discussed in the publication just mentioned. The vertical part of the arcuate or precentral inferior sulcus in young specimens of orang-utan is located anteriorly and is separated off in the further development as the diagonal sulcus, while a new vertical part develops which probably delimits cortical area more precisely, and constitutes the new precentral inferior sulcus.

In this connection a reference may be made to von Economo ('27, p. 20) who states that frequently the boundary between the single areas of the cortex is indistinct and that there is a gradual transition which may extend to half or even to a whole gyrus. These facts suggest that the variability in the position of the sulci reflects the existence of these transition zones and would

also account for the findings of brain histologists that the sulci often border the areas only approximately. If this interpretation is correct then the sulci take on an importance hitherto unrecognized.

That the sulci limit the cortical areas at least approximately, and often precisely, is at once apparent on examination of the cytoarchitectural maps of the authors. To cite recent publications confirming in the main earlier published cortical maps, there is the monograph of von Bonin and Bailey ('47) on *Macaca* showing transitional zones but still a very close relationship of sulci and cortical areas. The study by Lashley and Clark ('46) on *Ateles* and *Macaca* gives a map of Ateles made independently by each author, which however different in details, the two maps show agreement in the relation of sulci to the areas. Even the small compensatory intraparietal sulcus limits dorsally a specific area. The authors show that there is considerable variability within the species.

The fact that the sulci do not always limit the same functional areas in the different taxonomic groups of primates is in itself an important biological phenomenon and quite understandable. Some of the sulci in the ascending zoological scale undergo a shift in position with respect to the areas, and this is to be expected because the basic areas enlarge and new areas are differentiated in higher forms so that new adaptations must be made. In this process a part of a primary sulcus may be budded off, or a new sulcus added. In some groups a sulcus may occupy a position within an area though it was formerly a limiting sulcus. This shows that the sulci have a deeply established inheritance pattern, and that the position of the sulcus in such cases is the result of the competitive influences of the hereditary factors and the influence of new cortical areas. The sulci in the higher primates may become again adjusted and limit the new areas very closely.

The morphology of the brain is probably of more significance in indicating the general evolutionary trend than that of any other single organ, for the reasons stated at the beginning of this paper. One can trace a continuous series of stages in the sulcal pattern from lemurs to the higher primates "as if" there were a

linear sequence of development and differentiation. We know that this is really not the case, however, since divergent specialized categories of forms branched off at various levels. But the stages do represent different levels attained in the phylogenetic development.

The brain of many genera of primates can be distinguished from one another. Where this does not seem possible, as in some of the Cercopithecidae, the brain not reflecting externally the various adaptive specializations, which the taxonomists regard as generic, its general structure indicates that these genera are at about the same level of organization. Even in these cases the cellular structure of the brain very probably would show differences.

### Homo

The brain of the great apes approaches closer to the human brain in size and fissuration than does the brain of any other primate. But the human brain even at the time of birth can be distinguished from any other brain. It is not a matter of mere increase in size; there is also more cortical differentiation in the human brain. New cortical areas appear and other areas show a great expansion. This cortical differentiation has its correlate in the appearance of new sulci and the modification of old ones by a bending and increase of branches which become axial or limiting sulci to the new areas. To this must be added the finer and more complex organization of the structure of the cortex in the human brain.

An opinion more generally held today is that man is more closely allied structurally to the anthropoid apes than to any other primate, but that the anthropoids, even in their early fossil representatitives so far as known, are too specialized to form a link in the chain of descent. Thus Le Gros Clark ('36) represents the hominid line as diverging from a common stem before the anthropoids developed their specializations; and in agreement with most authorities, the gorilla and chimpanzee are regarded as having differentiated from one another at a later period. Schultz ('36) also interprets the data as indicating an early divergence of

the hominid line, later, however, than the gibbon but earlier than the anthropoids.

Le Gros Clark ('36) has drawn attention to the frequently occurring phenomenon of parallelism in primates. The increase in the size of the brain in anthropoids and man has also been regarded as a case of parallelism by several authors. It is not mere size, however, that must be considered, but also an increase in the differentiation of the cortex.

When the similarities of fissuration are such as do exist in the human and anthropoid brain, one is inclined to conclude that there is a closer phylogenetic relationship between the two than between man and the lower primates. But judging from the fossil record the relationship must be distant. From a genetic standpoint, the view that the similarities in the brain morphology of man and the anthropoids are the result of evolutionary parallelism is understandable. The basic fissural pattern of the brain seen in all primates is one evidence of a basic primate gene equipment. The various ascending taxonomic groups have increasing cortical differentiation as reflected in the fissural pattern. This pattern is typical of each group and is inherited as surely as nose-shape and eye-color in man are inherited. Each of these groups has a special combination of genes, mutated and unmutated, determining the characteristic pattern. There is a great increase in complexity of the pattern when we come to the great apes and man and also, as already stated, many similarities between the two. These similarities could result from parallel mutations of genes present in the common stem. The resemblances could hardly be explained by convergence in the proper sense of that term, namely, a resemblance between types which have different lines of descent. The resemblances in this case are likely to be more superficial.

Just when the lines of descent diverged from a common stem can only be decided by the fossil record. There is, it may be repeated, a great difference in the size and complexity of man's brain compared with that of the anthropoids. The brain is man's most specialized anatomical character, the physical basis of his psychic life, which in conceptual thought and use of symbolic language transcends the psychic life of subhuman animals.

## RACIAL DIFFERENCES IN THE BRAIN

The earlier investigators of the comparative morphology of the brain of different races, approached the subject with optimism and perhaps with a few preconceived notions as to what was likely to be observed. The search seemed to be for some primitive character in the brain and it was assumed that this character would be found especially in the so-called inferior races. It was even maintained on the basis of the configuration of the sulci, that one group of races possessed an "orangoid" pattern, another the "gorilloid," in support of a polyphyletic origin of man. Much of the discussions of these investigators centered around the lunate sulcus which is a constant feature of the brain of infrahuman primates. The sulcus was of course found in the brain of primitive peoples, but further research revealed that it was also found, with varying percentages, among the brains of all races investigated.

Kohlbrugge ('09) made a study of the brains of Javanese, Malayan, Australian and Dutch peoples, representing different cultural levels, and concluded that any morphological feature in the sulcal pattern of one group could be found in any other group. Kohlbrugge's statement could of course be made of almost any other bodily character. But the combination of these morphological features or the sulcal pattern may differ nevertheless in different races.

If the brain morphologists of the 19th and the beginning of the 20th century expected too much from the brains in different races, some recent literature has shown a tendency to expect too little. There is first of all the form of the brain which is correlated with the form of the cranium and which shows some typical differences in human races. Then there is the influence, though very limited, of the form of the brain on the direction of the sulci in dolicho- and brachycephalics. A particular sulcus like the lunate, as mentioned above, may be found in the brain of all races, but the frequency of its presence differs and also the form and degree of development differ in different races. The frequency of the presence of the lunate in various races is difficult to ascertain from the literature because it is apparent that in some cases only

the typically formed lunate was recorded; in others the final
stages before its disintegration were included. Furthermore, as
it is obvious from good photographs and distinct labelling in
some relatively recent literature, the lunate is confused with the
transverse occipital, or with the lateral calcarine, or even with
the parieto-occipital sulcus. Where such confusion exists in the
identification of the lunate sulcus, statistics on its frequency in
different races are valueless.

It is almost generally agreed that there is but one living species
of man, and so it is not surprising that any single morphological
feature of the brain may appear in any race. But as already
noted, there is a difference in the frequency of morphological fea-
tures of the brain in different races. And there is evidence that a
combination of morphological features may occur in the brain of
some races which has not been found in other races. There are
now a number of published researches by investigators of the
brain of several races represented by a considerable number of
specimens, and these researches concur in this general conclusion.
It is of some importance to taxonomy that the brain reflects in
some measure the racial differences of man.

### Knowledge of Brain from Endocrinal Casts

A source of information concerning brain morphology about
which there is wide difference of opinion, is that of endocranial
casts. Some disregard completely the possibility of ascertaining
anything of value about the brain, even of its size, from en-
docranial casts. It can be said, however, that a fairly accurate
knowledge can be obtained of both size and form of brain from
the casts. The length-breadth index of the cast approximates
closely that of the corresponding brain, in comparisons made by
the present writer. Of the absolute dimensions, naturally the
height shows greater differences. This is true of both anthropoid
and man.

In modern man there is, as a rule, only little of fissural impres-
sions indicated on the casts, and this on the ventral aspects and
on the lower frontal and temporal regions. But under certain
conditions, the fissural impressions may extend over a consider-
able portion of the vault and factors producing this effect can be

explained.  It is by such comparative tests of the endocranial cast with the well preserved corresponding brains that once occupied the cranial cavity, that one may proceed with confidence to interpret the markings on endocranial casts.  The fact that as a general rule fissural impressions on the vault of the casts of the great apes and recent man are meager is no reason for the almost complete neglect of the matter.  For the casts sometimes *do* reveal much of brain fissuration and the resulting knowledge may be of great importance in assigning the taxonomic position of a fossil type.

In the study of fossil skulls of lower primates such as the lemurs, it is important to realize that, judging from living representatives of this group, much could be learned of even the fissuration of the brain from the casts.  Still more important is the fact that the endocranial casts of the gibbon normally show a remarkable reproduction of the brain fissures.  The finding of skull remains of an allied group belonging to the Miocene period could probably throw much light on the relationships of the higher primates of the past.

### The South African Man-apes
#### AUSTRALOPITCHECINAE

In 1924 the fossil remains of the skull of a young creature were found at Taungs, South Africa.  Professor Dart ('25) described the find and was convinced that it represented a primate occupying a position about intermediate between anthropoid apes and man.  He gave it the name Australopithecus africanus.  From 1936 on, new discoveries chiefly by Dr. Broom and his assistants, of allied forms followed in rapid succession and all were placed in a new subfamily, the Australopithecinae.  Though the finds were frequently fragmentary, enough was revealed to indicate their importance in the problem of evolution.  The significance of these fossil remains rests chiefly in the fact that the teeth are more hominoid than any ape, living or fossil, and that the pelvis indicates that the creatures walked erect.  Zukerman ('51) in a study of the dentition of the Australopithecinae, found that the teeth did not show statistically significant differences from those of living apes, but other investigators obtained different results

from their statistical analysis. Le Gros Clark ('50) in a qualitative and metrical study of the dentition concludes that the teeth are more human-like than ape-like.

We are here interested, however, in any information that may be gathered about their brains from the endocranial casts. Dart ('25) estimated the cranial capacity of the Taungs Ape as 520 c.c., and Keith as 450 to 500 c.c. Both estimates fall within the range of the gorilla. A three year old gorilla specimen preserved in the U.S. National Museum has a cranial capacity estimated at 500 c.c. Another skull allied to the Taungs skull was found in 1936, and a more perfect one in 1947. To this type the name Plesianthropus transvaalensis was given. Its cranial capacity was estimated at 482 c.c.

Mention may be made here of a morphological feature present in the skull of Plesianthropus which is regarded as a hominid character. Broom, Robinson and Schepers ('50) quote Weidenreich as stating that "One of the most characteristic peculiarities wherein the anthropoids differ from hominids is the way in which the lateral contour of the frontal lobe . . . meets that of the temporal lobe at the place where the sylvian fissure runs upwards and backwards. In Gorilla and Chimpanzee the contour of the frontal lobe continues the upward and forward direction of the temporal lobe while in early hominids, even if the brain is as small as that of Pithecanthropus, there is a distinct indentation and change in the direction of the outline. This marks a difference in the character of the sylvian fissure."

Schepers states that "Plesianthropus shows the whole of this (Sylvian) region in perfect condition and there is about as deep an indention in the brain as there is in man." The ridge of bone in the skull which corresponds to the Sylvian indentation in the brain, is well seen in Schepers' photograph of the internal aspect of the skull (Plate 4, fig. 16).

This character which Weidenreich regards as important in distinguishing man from ape, as will be shown below, is not diagnostic. Plesianthropus has some hominoid characters, but the existence of a Sylvian indentation or depression in the brain is not one of them.

Another member of this subfamily has been described by

Broom and Robinson ('52). Mandibles with associated teeth and parts of the face below the orbits are first discussed. Two skulls of supposed females and one of a child are described. The name **Paranthropus crassidens** has been given to this type. The first skull, discovered in 1950, is "somewhat crushed" and the upper part of the occiput is missing. The authors state that "the skull is much more gorilla-like than man-like." This is also obvious from the drawings. The supraorbital ridges, the nasal region and especially the prominent sagittal crest, considering that it is regarded as a female, are typically ape-like. It would seem hazardous to give a fair estimate of the cranial capacity in this case. The authors give 750 c.c. as probable. A second skull found "badly crushed" has an estimated cranial capacity of 800 c.c.

A very large jaw, apparently of a female, together with the lower part of the face and part of the palate, are also described. "The whole of the nasal region is essentially similar to that of the chimpanzee." Part of the left and right sides of the mandible are missing and the two sides are crushed together. On the basis of this defective material showing so many ape characters, and the restoration of the top of the skull based on two female skulls, an estimate is made of the cranial capacity! It is estimated to be probably over 1000 c.c. Such a procedure, it may be justly stated, will not advance our knowledge of the Australopithecinae.

We are accustomed to think that in the phylogenetic series, the brain enlarged with the *reduction* in the size of the jaw and not with its increase. As sometimes expressed, the larger the jaw the smaller the brain. Paranthropus with its many gorilla-like features of the skull, would seem to be already too specialized in the anthropoid ape direction, to be admitted in the family Hominidae, as some authors have suggested.

Mayr ('50), however suggests that even the Australopithecinae could be included in the same genus (Homo) as Modern Man and Java Man. This suggestion is made on the assumption that the principal generic character of Homo is the possession of an upright posture.

It may be first observed that the Australopithecinae are said

to have attained the upright posture *"or almost."* Again La Chapelle Man reveals morphological characters in his skeleton indicating that he walked in a stooped manner, though he buried his dead and indeed in a ritual way. Schultz ('50) has drawn attention to the tendency of subhuman animals to assume the erect posture. "The anthropoid apes all can stand fully erect at will" he states and "one encounters individuals which, without having been trained by man, will *walk* upright on the ground slowly and deliberately, and with the knees hardly more bent than in some men." Accompanying the article is a figure of a gorilla sketched by the artist Mr. C. R. Knight. It represents the gorilla walking not merely upright like the average human, but in quite a soldierly fashion!

It is more generally agreed, however, that the principal generic characters that distinguish man from the lower animals, and recognized expressly as such, at least since the time of the Greek philosophers, are his psychic qualities.

After a recent examination of the various discovery sites of the Australopithecinae, and fully recognizing the zoological importance of this group, P. Teilhard de Chardin ('52) concludes that, "In no case, until now, neither in their brain capacity, nor by the reduction of their face, nor by any association of their bones with any trace of fire or any true implements can the Australopithecines (in contrast to the Pithecanthropines) be considered as a zoological group which, at any time, crossed the divide between Ape and Man."

### Endocranial Casts of Early Man

The endocranial casts of the early hominids reveal more of the brain fissures than is usually the case in recent man. It was from the fissural impressions on the frontal region that the hominid status of Pithecanthropus was largely determined and all further studies including those on the more recently discovered specimens of this fossil type confirmed this opinion. The cranial capacity is estimated to be about 900 to 940 c.c.

The endocranial cast of the adolescent pithecanthropus pekinensis (Sinanthropus) shows some similarity with that of Pithecanthropus erectus (Dubois), but it definitely indicates a

brain of a higher type especially seen in the elevation of the frontal lobe region. The fissural impressions on this region are also more complex and reach higher on the vault. Davidson Black ('34) estimated the cranial capacity of this adolescent specimen to be 964 c.c. The endocranial casts of the later discovered specimens of Sinanthropus give larger cranial capacities well within the range of living man and thus show a great advance over Pithecanthropus erectus.

Weidenreich ('43) gives the cranial capacity of one of the Sinanthropus specimens as 1225 c.c. The Pithecanthropus skull discovered by von Koenigswald has a cranial capacity of only 775 c.c. Further discoveries may reveal specimens with a higher cranial capacity than this or the Dubois specimen. But with the present available material, Sinanthropus seems to be a higher type than Pithecanthropus erectus. In addition to the larger brain size, there is the interesting fact that the skeletal remains were found associated with cultural remains. Sinanthropus was the maker of stone artifacts and this is in harmony with the organization of his brain as revealed by the endocranial casts.

Davidson Black ('34), while noting some morphological similarities of Sinanthropus and Pithecanthropus, stressed the progressive features of the former compared with the latter.

The question arises if it is justifiable to exclude Sinanthropus from the genus Homo. Even from a purely morphological point of view, Simpson ('45) states that all known hominids, recent or fossil, could well be placed in Homo. He makes a possible exception for Pithecanthropus (including Sinanthropus as synonymous). But with the advanced features exhibited in both skull and brain of Sinanthropus, and the evidence of associated cultural remains together with the fact that he had a knowledge of the use of fire, it would seem logical to assign Sinanthropus to the genus Homo.

Solo Man. There never was any doubt that the eleven skulls with the face and jaws missing, which were found at Ngandong, Java on the Solo River, were the remains of individuals of the genus Homo. The type was at first regarded by some as belonging to the Neanderthal group. Vallois ('35) noted some morphological resemblances to the skull of Rhodesian Man. The

name Homo (Javanthropus) soloensis was given to the type by Oppenoorth who first described the skulls.

The skulls are massive and their walls very thick so that the cranial capacities are not so great as one would expect from the external dimensions. The cranial capacity of the largest skull (Skull V) is estimated to be about 1255 to 1300 c.c. The average cranial capacity has been estimated to be only 1100 c.c. which is much below the average of Neanderthal Man.

Ariëns Kappers ('36b) noted that the shape of the endocranial cast is quite primitive—"approaching in some respects the Sinanthropus casts." This is apparent from the photographs of the dorsal aspect of the cast.

Weidenreich ('43) came to the conclusion that Solo Man was "not a Neanderthalian in the strict sense. He is much closer to the Sinanthropus-Pithecanthropus stage and therefore intermediate between this and the Neanderthal stage." In a later paper, Weidenreich ('47) discussed the endocasts more in detail. He observed that while in Pithecanthropus and Sinanthropus a Sylvian depression corresponding to the Sylvian fissure of the brain was present, no such depression was seen on the endocasts of Homo soloensis, notwithstanding the general similarities with that group. In this feature the endocast revealed resemblances to the Neanderthal casts.

The Sylvian depression on an endocast is due to a ridge or crest in the skull which passes backward from the lesser wing of the sphenoid and is frequently interrupted.

Weidenreich considers the condition in the same region of anthropoids, and observes that "It is a characteristic feature of the endocast of all 3 anthropoids that there is no indentation where the frontal and temporal lobes meet, neither is there any depression in the entire Sylvian area." The deficiency in the Sylvian area present in early man is, the author concluded, not a "simian" character but one specifically human.

It is true that many endocranial casts of the three great anthropoids do not show a Sylvian notch or depression. The present writer ('50) has shown, however, that both a Sylvian notch and depression occur on the endocranial casts of all three large anthropoids, though less frequently in the gorilla. They also occur,

and with greater preciseness on the endocast of the gibbon. The presence of the depression, it was shown in that publication, depends to a great extent on the age of the specimen. In the very young, the Sylvian crest is not fully developed; in the old the developed crest undergoes resorption and as noted especially in the gorilla, there is no sharp demarcation separating the anterior from the middle cranial fossa so that a Sylvian crest is absent. The Sylvian depression on the endocasts of the large anthropoids represents not only the Sylvian fissure but also the anterior part of the superior temporal sulcus. In the gibbon, the superior temporal sulcus is represented on the endocast as a furrow distinct from the Sylvian.

The interpretation of the presence or absence of the Sylvian depression discussed by Weidenreich is of great importance considering the broad application he makes of this morphological feature. He interprets the depression as not only representing an open Sylvian fissure, but also a deficiency in the cortex of the adjacent parts of the brain and he concludes that the insula of Reil in such cases is exposed. In the same article Weidenreich refers to an observation of the present writer, where an endocranial cast of a modern human skull shows a Sylvian depression and the corresponding brain reveals an "open" Sylvian fissure when viewed from in front. Unfortunately my communication to Weidenreich was partly misunderstood.

The true condition described in this writer's ('50) publication may be briefly stated here. The endocast shows a wide and deep Sylvian notch as if the temporal and frontal regions were wedged apart. A deep Sylvian depression follows and gradually becomes shallow to about the level of the extremity of the Sylvian fissure of the brain. From this condition one might conclude that the anterior part of the insula was exposed and the lips of the Sylvian fissure were spread apart, thus showing a considerable cortical deficiency in this region. But an examination of the corresponding brain shows quite a different condition. The brain was fixed while still in the skull so that the separation of the frontal and temporal lobes, revealed by the endocast was maintained in the extracted brain. Hence when viewed in front

one could see part of the insula. But the insula was no more exposed than in the average brain and the Sylvian fissure was completely closed.

The above facts lead one to suggest a different interpretation from that of a cortical deficiency when a Sylvian depression is present. In the present case the skull of a 51 year old individual was very thick and the Sylvian crest well developed. The initial cause of the Sylvian depression may be found in the overgrowth of the crest invading this region of the brain which had long before ceased growing. The result is that the temporal lobes of the brain bulge outward along their central axis, much as in the case of the endocast of Sinanthropus.

In a monograph published posthumously, Weidenreich ('51) describes the skulls of Solo Man in detail. The base of the skull is well preserved in Skulls VI and Skull IX. Rubber endocasts were made through the occipital foramen and the artificial openings in the orbital region. Weidenreich states that "In some regions, especially the anterior fossa cerebri in Skull VI and the media fossa in Skull XI, the matrix, which consisted of hard crystals adhering to the bone, could not be completely removed. Consequently the results are not satisfactory."

The more recent geological evidence regarding the time of the existence of Solo Man points to the last glacial period. Hence he is too late on the scene to play a role in the development of modern man.

Neanderthal Man. The cranial capacity of the female Neanderthal Steinheim skull, which even possesses neanthropic features, is well below the cranial capacity (1225 c.c.) of one specimen of Sinanthropus. When one places in series the endocranial casts of the early hominids and links them with the casts of the Neanderthals, one becomes aware of the continuity in size of the members of the series. The shape of the casts of course differs and accords with the outlines of the brain-case as given in the morphological descriptions.

One important fact established in recent years is that the Neanderthal group shows great variability in the size and other morphological features of the skull. The skulls range from those

with primitive characters and characterized as paleoanthropic to those with progressive or neanthropic features approaching those of the modern type of skull. This has led to a reconsideration of the old problem as to whether Neanderthal Man became extinct or was absorbed or mixed with another more advanced type. Reference may be made here to an early paper by Hrdlička ('27). In his Huxley Lecture, Hrdlička presented good reasons for the view, later accepted by Keith and Weidenreich and now becoming more generally accepted, that Neanderthal Man represents a phase in the evolution of man, rather than a distinct species that disappeared from the earth.

The wide spatial distribution of Neanderthal Man was such that it is difficult to believe that he could have become extinct. The early appearing type exhibits neanthropic features in the skull. It is a *generalized* type compared with the later and extreme or *specialized* type, to use the appropriate terms of Le Gros Clark ('50). While there are good reasons for believing that the generalized type of Neanderthal Man did not become extinct, it is quite possible that the specialized or extreme type did not survive.

The modern type of man, now characterized by certain morphological features of the skull compared to those of early man, is referred to as *Homo sapiens*. This specific name was established by Linnaeus as the proper scientific one for the human species. The application of the term "non-sapiens" to such types as the Neanderthal or to any other type of Homo seems incongruous. It implies a psychic character of which no account is otherwise taken in making comparisons of morphological features. Although the brain is the seat of mental operations, a skull is often placed in the category of the "non-sapiens" type solely on the presence of a supraorbital torus and its correlated structures or on the presence of an occipital ridge! As the comparisons of the different types of fossil hominids are made on a morphological basis, and their inclusion in the genus Homo made on the evidence of their cultural remains, it is more appropriate to use the term paleoanthropic for the primitive type and the term neanthropic for the modern type of man.

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